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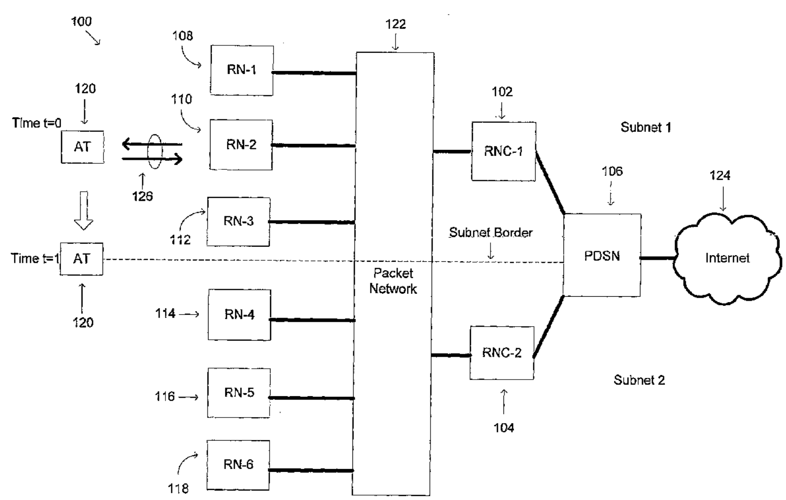
(54) Title: RADIO NETWORK CONTROL



(57) Abstract: The radio node controller of one subnet sends a communication to an access terminal over a control channel through the infrastructure of another subnet. The radio node controller maintains an open traffic channel with an access terminal when the access terminal moves from a coverage area of the first subnet to a coverage area of the second subnet and when the access terminal uses a carrier in the first subnet that cannot be used in the second subnet. In a radio access network including a first and a second subnet, in which the first subnet includes both a first radio node controller and radio nodes that are configured in accordance with one 1xEV-DO standard and the second subnet includes radio nodes configured in accordance with another 1xEV-DO standard, the first radio node controller maintains an open traffic channel with an access terminal when the access terminal moves from the coverage area of the first subnet to the coverage area of the second subnet.

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RADIO NETWORK CONTROL

TECHNICAL FIELD

This invention relates to radio network control.

BACKGROUND

High Data Rate (HDR) is an emerging mobile wireless access technology that enables personal broadband Internet services to be accessed anywhere, anytime (see P. Bender, et al., "CDMA/HDR: A Bandwidth-Efficient High-Speed Wireless Data Service for Nomadic Users", IEEE Communications Magazine, July 2000, and 3GPP2, "Draft Baseline Text for 1xEV-DO," August 21, 2000). Developed by Qualcomm, HDR is an air interface optimized for Internet Protocol (IP) packet data services that can deliver a shared forward link transmission rate of up to 2.46 Mbit/s per sector using only (1X) 1.25 MHz of spectrum. Compatible with CDMA2000 radio access (TIA/EIA/IS-2001, "Interoperability Specification (IOS) for CDMA2000 Network Access Interfaces," May 2000) and wireless IP network interfaces (TIA/EIA/TSB-115, "Wireless IP Architecture Based on IETF Protocols," June 6, 2000, and TIA/EIA/IS-835, "Wireless IP Network Standard," 3rd Generation Partnership Project 2 (3GPP2), Version 1.0, July 14, 2000), HDR networks can be built entirely on IP technologies, all the way from the mobile Access Terminal (AT) to the global Internet, thus taking advantage of the scalability, redundancy and low-cost of IP networks.

An EVolution of the current 1xRTT standard for high-speed data-only (DO) services, also known as the 1xEV-DO protocol has been standardized by the Telecommunication Industry Association (TIA) as TIA/EIA/IS-856, "CDMA2000 High Rate Packet Data Air Interface Specification", 3GPP2 C.S0024-0, Version 4.0, October 25, 2002, which is incorporated herein by reference. Revision A to this specification has been published as TIA/EIA/IS-856, "CDMA2000 High Rate Packet Data Air Interface Specification", 3GPP2 C.S0024-A, Version 2.0, June 2005, but has yet not been adopted. Revision A is also incorporated herein by reference.

FIG. 1 shows a 1xEV-DO radio access network 100 with radio node controllers 102 and 104 connected to radio nodes 108, 110, 112, 114, 116, 118 over a packet network 122. The packet network 122 can be implemented as an IP-based network that supports many-to-many connectivity between the radio nodes and the radio node

controllers. The packet network is connected to the Internet 124 via a packet data serving node (PDSN) 106. Other radio nodes, radio node controllers, and packet networks (not shown in FIG. 1) can be included in the radio access network. The packet network 122 may be several distinct networks connecting individual radio node controllers to their associated radio nodes, or it may be a single network as shown in FIG. 1, or a combination.

Typically, each radio node controller controls 25-100 radio nodes and each radio node supports 1-4 carriers each of 1.25 MHz of bandwidth. A carrier is a band of radio frequencies used to establish airlinks with access terminals. The geographic area of the radio access network that is served by any given radio node is referred to as a cell. Each cell can be divided into multiple sectors (typically 3 or 6) by using multiple sectorized antennas (the term "sector" is used both conventionally and in this document, however, even when there is only one sector per cell).

Access terminals 120 communicate with the network 100 over airlinks 126. Each access terminal may be a laptop computer, a Personal Digital Assistant (PDA), a dual-mode voice/data handset, or another device, with built-in 1xEV-DO Rev-0 or Rev-A support. The airlink 126 between the network 100 and an access terminal 120 includes a control channel over which a serving radio node controller (i.e., the radio node controller on which a 1xEV-DO session of the access terminal 120) transmits messages and parameters that the access terminal 120 may need for access and paging operations. The messages and parameters (collectively referred to in this description as "control channel messages") convey system parameters, access parameters, neighbor lists, paging messages, and channel assignment information to the access terminal 120.

Access terminals 120 periodically send route update messages to the network 100. Each route update message identifies the sectors that are "visible" to the access terminal 120. The visible sectors may include sectors of radio nodes that are not controlled by the access terminal's serving radio node controller.

When a packet destined for an access terminal 120 is received at the serving radio node controller 102, the serving radio node controller 102 selects a set of sectors on which the access terminal 120 is to be paged, and sends a paging message to the selected sectors over respective control channels. One selection method known as "flood paging" involves selecting the sectors of all of the radio nodes that are controlled by the access terminal's serving radio node controller. Another selection method

known as "selective paging" involves selecting only the visible sectors (or a subset of the visible sectors) of radio nodes that are controlled by the access terminal's serving radio node controller.

In a scenario in which the access terminal is located at or near the border of two sectors, both of which are visible to the access terminal but only sector A is controlled by the access terminal's serving radio node controller, the network is limited to sending paging messages, UATI_Assignment messages, and/or TrafficChannelAssignment messages to the access terminal over the control channel of the single sector A.

In a scenario in which an active access terminal crosses over the border between two sectors that are on different carriers and/or subnets, an inter-carrier and/or inter-subnet hard handoff is performed between the radio node controller's controlling the radio nodes associated with the two sectors. The user disruption associated with such hard handoffs are generally in the order of 5-10 seconds.

In both scenarios, lower success rates are generally associated with the activities (e.g., paging, UATI assignment, traffic channel assignment, and hard handoffs) that take place when an access terminal is located at or near a carrier and/or subnet boundary.

SUMMARY

In general, in one aspect, the radio node controller of one subnet sends a communication to an access terminal over a control channel through the infrastructure of another subnet. Implementations may include one or more of the following features: The communication comprises packets. The infrastructure includes a radio node controller. The access terminal is in an idle state. The communication sent over the control channel comprises a paging message, UATI_Assignment message, or TrafficChannelAssignment message. The access terminal notifies the radio node controller of sectors that are visible to the access terminal. The access terminal notifies the radio node controller of information about pilot strengths of sectors that are visible to the access terminal. The notification sent by the access terminal is sent as a route update message. The radio node controller determines, based on the pilot strengths, to which sectors to send a communication over the control channel to the access terminal. The radio node controller sends a communication to the access terminal over a control channel via sectors chosen based on their pilot signal strengths as reported by the

access terminal, where at least one chosen sector is located in a different subnet than the radio node controller.

In general, in one aspect, the radio node controller maintains an open traffic channel with an access terminal when the access terminal moves from a coverage area of the first subnet to a coverage area of the second subnet and when the access terminal uses a carrier in the first subnet that cannot be used in the second subnet.

Implementations may include one or more of the following features: Each of the carriers comprises an operating frequency. The radio nodes in the first subnet are configured in accordance with one 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard. The radio nodes in the first subnet are configured in accordance with the 1xEV-DO Rev-A standard and radio nodes in the second subnet are configured in accordance with the 1xEV-DO Rev-0 standard.

In general, in one aspect, in a radio access network including a first and a second subnet, in which the first subnet includes both a first radio node controller and radio nodes that are configured in accordance with one 1xEV-DO standard and the second subnet includes radio nodes configured in accordance with another 1xEV-DO standard, the first radio node controller maintains an open traffic channel with an access terminal when the access terminal moves from the coverage area of the first subnet to the coverage area of the second subnet.

Implementations may include the following feature: The radio nodes of the first subnet are configured in accordance with the 1xEV-DO Rev-A standard and the radio nodes of the second subnet are configured in accordance with the 1xEV-DO Rev-0 standard.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIGS. 1-3 each show a radio access network.

DETAILED DESCRIPTION

In the illustrated example of FIG. 1, the network 100 is divided into two 1xEV-DO subnets, each having a radio node controller 102, 104 and three radio nodes 108-118.

Each radio node has a primary association with the radio node controller in its subnet and may have a secondary association with a radio node controller in another subnet. Generally, when a radio node has a primary association with a radio node controller, messages can be exchanged over the forward and reverse traffic channels, the control channel, and the access channel. When a radio node has a secondary association with a radio node controller, messages can only be exchanged over the forward and reverse traffic channels. That is, no messages are exchanged over the access and control channels. Additional information concerning the primary and secondary associations between radio nodes and radio node controllers are described in U.S. Application Serial Nos. 11/037,896 filed on January 18, 2005, 09/891,103, filed on June 25, 2001, and 10/848,597, filed on May 18, 2004, and incorporated by reference.

In some implementations, the network operator further configures the radio node controllers to have a border association with certain radio nodes in another subnet. Typically, the radio nodes with which a radio node controller has a border association are geographically located at or near the subnet boundaries. The border association concept extends the secondary association concept by enabling a radio node controller to exchange messages over the control channel with radio nodes of another subnet without passing through another radio node controller.

As an example, suppose the network operator configures the radio node controller RNC-1 102 to have a primary association with the radio nodes RN-1 108, RN-2 110, RN-3 112, and a border association with the radio node RN-4 114. An idle access terminal moving within the coverage areas of the radio nodes RN-1, RN-2, RN-3 sends route update messages to the radio node controller RNC-1 to identify the sectors that are visible to the access terminal 120, and for each visible sector, its associated pilot strength. In instances in which the idle access terminal is in the coverage area of the radio node RN-3, the last sent route update message will likely identify, as visible, one or more sectors associated with the radio node RN-4. The sector identification and the relative pilot strengths enable the radio access network to

keep track of the access terminal's approximate location within the footprint of the network.

When a packet destined for the idle access terminal 120 is received at the radio node controller RNC-1, the radio node controller RNC-1 uses the last sent route update message to select a set of sectors on which the idle access terminal 120 is to be paged. In some implementations, the radio node controller RNC-1 sends a paging message to the idle access terminal 120 over the control channel of each of the radio nodes with visible sectors. In some implementations, the radio node controller RNC-1 examines the pilot strengths of the visible sectors, identifies those visible sectors associated with the relatively stronger pilot strengths, and sends a paging message to the idle access terminal 120 over the control channel of each of the radio nodes with the identified visible sectors.

In those instances in which the selected set of sectors includes sectors of the radio node RN-4 with which the radio node controller RNC-1 has a border association 130 relationship, a paging message can be sent from the radio node controller RNC-1 to the radio node RN-4 over the control channel. By enabling the idle access terminal 120 to be paged on the sectors associated with the radio node RN-4 as well as those associated with the radio node RN-3, the radio node controller RNC-1 increases the likelihood of receiving a page response from the access terminal 120. In so doing, the network enhances paging reachability for access terminals located at or near the subnet border, which in turn results in a higher page response success rate.

In other examples, rather than sending a paging message only to those sectors identified as visible in the last sent route update message, the radio node controller RNC-1 can be implemented to select a subset of the sectors of its subnet or adjoining subnet in accordance with the distance-based selective techniques described in U.S. Application Serial Nos. 11/243,405 filed on October 4, 2005, and incorporated by reference, and send the paging message over the control channel of each of the radio nodes associated with the selected subset of sectors.

In other examples, rather than use the last sent route update message to select a set of sectors on which the idle access terminal 120 is to be paged, the radio node controller RNC-1 can be implemented to send a paging message over the control channel of each of the radio nodes with which the radio node controller RNC-1 has a

border association. Such a subnet-wide paging technique also enhances the page response success rate for access terminals located at or near the subnet border.

In addition to enhancing paging reachability, the border association concept can be implemented to enhance control channel messaging reliability overall. As an example, an access terminal 120 in the coverage area of the radio node RN-3 can send a UATI_Request or a ConnectionRequest message over access channels of the radio node RN-3. Typically, the UATI_Request or ConnectionRequest message is accompanied by a route update message, which may include, as visible, the sectors of the radio node RN-4 if the access terminal is at or near the subnet boundary. The messages are forwarded by the radio node RN-3 to the radio node controller RNC-1, which processes the request and generates a UATI_Assignment or TrafficChannelAssignment message as appropriate. The radio node controller RNC-1 then sends the UATI_Assignment or TrafficChannelAssignment message to the access terminal over the control channel of each of the visible sectors including those of the radio node RN-4. In those instances in which the access terminal is at or near the subnet boundary, delivery of the UATI_Assignment or TrafficChannelAssignment message over the control channels of the sectors of the radio node RN-4 increases the likelihood of the access terminal receiving the message, thus enabling the network to achieve a higher A13 dormant handoff or connection setup success rate.

In some implementations, the radio node controllers of the 1xEV-DO network 100 of FIG. 1 support multi-carrier sectors. FIG. 2 shows a network coverage area with two carriers C1 and C2, where C1 operates in the sectors S1-S8 of both subnets 1 and 2, and C2 operates only in the sectors S1-S4 of subnet 1. In some implementations, the radio node controllers of the 1xEV-DO network 100 of FIG. 1 support multi-carrier, multi-revision sectors. FIG. 3 shows a network coverage area with two carriers C1 and C2, where C1 operates in the sectors S1-S8 of both subnets 1 and 2, and C2 operates only in the sectors S1-S4 of subnet 1. The sectors S1-S4 of subnet 1 are served by Rev-A capable radio nodes, and the sectors S5-S8 of subnet 2 are served by Rev-0 capable radio nodes. As 1xEvDO Rev-A is backwards compatible with 1xEvDO Rev-0, Rev-A capable access terminals can operate in either Rev-0 mode or Rev-A mode, depending on whether its serving radio node is Rev-0 or Rev-A capable.

Referring to FIGS. 1, 2 and 3, during network design, the network operator designates the sectors (in this case, sectors S4 and S5) at the subnet boundary as border

sectors, configures the radio node RN-2 110 and RN-3 112 (which collectively serve the sectors S1-S4) to have a primary association with the radio node controller RNC-1 102 of subnet 1, and configures the radio node RN-4 114 (which serves sector S5) to have a secondary association with the radio node controller RNC-1 102 of subnet 1.

As an active access terminal 120 operating on carrier C2 moves within the coverage area of the subnet 1, the access terminal 120 periodically sends route update messages to the serving radio node controller RNC-1 102 to identify the sectors that are visible to the access terminal 120. For each visible sector, the access terminal 120 provides its associated pilot strength. When serving radio node controller RNC-1 102 detects that the pilot strength associated with the border sector S5 is stronger than the other pilot strengths being reported, the serving radio node controller RNC-1 102 sends a TrafficChannelAssignment message to the access terminal 120. Upon receipt of the message, the access terminal 120 processes the TrafficChannelAssignment message to change the carrier on which it operates to the carrier specified in the TrafficChannelAssignment message. In this case, the access terminal will operate on carrier C1 after the TrafficChannelAssignment message is processed. If the access terminal has any data to send, the access terminal will send it through RNC-1 on carrier C1. This can be done with no interruption in service for the access terminal.

In another implementation, a Connection Close message and a Unicast Redirect message can be used in place of the TrafficChannelAssignment message. When serving radio node controller RNC-1 102 detects that the pilot strength associated with the border sector S5 is stronger than the other pilot strengths being reported, the serving radio node controller RNC-1 102 sends a Connection Close message and a Unicast Redirect message to the access terminal 120. Upon receipt of the message, the access terminal 120 first processes the Connection Close message to close the connection, and then processes the Unicast Redirect message to change the carrier on which it operates to the carrier specified in the Unicast Redirect message. In this case, the access terminal will operate on carrier C1 after the Unicast Redirect message is processed. If the access terminal has any data to send, the access terminal will initiate another connection request on the carrier C1 and the serving radio node controller RNC-1 will establish an active traffic channel by allocating traffic channel resources on the carrier C1. The user disruption associated with the "close connection-switch carrier-open connection" process typically averages about 1 second long.

If the active access terminal crosses the subnet boundary into the coverage area of the sector S5, the secondary association established between the radio node RN-4 114 (which serves the sector S5) and the radio node controller RNC-1 102 enables the user activity (e.g., phone call, data transfer) to continue uninterrupted as the radio node controller RNC-1 102 remains the serving radio node controller for the traffic channel operating on the carrier C1.

If the access terminal 120 moves back into the coverage area of the sector S4 of the subnet 1, the access terminal 120 will continue to operate on the carrier C1. If, however, the access terminal 120 moves further into subnet 2, for example, into the coverage area of the sector S5 which the radio node controller RNC-1 102 has no relationship with and therefore no control over, a hard handoff between the radio node controllers RNC-1 102 and RNC-2 104 is triggered.

The techniques described with reference to FIGS. 2 and 3 improve network reliability by minimizing the number of dropped data connections that may occur when an active access terminal crosses over a subnet boundary into a coverage area of a sector operating on a different carrier and/or 1xEV-DO revision. Further, the techniques reduce the number of hard handoffs that are performed by the network by limiting those hard handoff instances to scenarios in which the access terminal has moved deep into the coverage area of a subnet (i.e., not at or near the subnet boundary). In so doing, network resources that would be tied up with the hard handoffs are made available for use by other components of the network.

Although the techniques described above employ the 1xEV-DO air interface standard, the techniques are also applicable to other CDMA and non-CDMA air interface technologies in which secondary associations and border associations can be established between radio nodes and radio node controllers.

The techniques described above can be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. The techniques can be implemented as a computer program product, i.e., a computer program tangibly embodied in an information carrier, e.g., in a machine-readable storage device or in a propagated signal, for execution by, or to control the operation of, data processing apparatus, e.g., a programmable processor, a computer, or multiple computers. A computer program can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form,

including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program can be deployed to be executed on one computer or on multiple computers at one site or distributed across multiple sites and interconnected by a communication network.

Method steps of the techniques described herein can be performed by one or more programmable processors executing a computer program to perform functions of the invention by operating on input data and generating output. Method steps can also be performed by, and apparatus of the invention can be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit). Modules can refer to portions of the computer program and/or the processor/special circuitry that implements that functionality.

Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. The essential elements of a computer are a processor for executing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. Information carriers suitable for embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or incorporated in special purpose logic circuitry.

A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention, and, accordingly, other embodiments are within the scope of the following claims.

What is claimed is:

CLAIMS

1. A method comprising

in a radio access network including subnets, in which at least one of the subnets includes a radio node controller,

enabling the radio node controller of one subnet to send a communication to an access terminal over a control channel through the infrastructure of another subnet.

2. The method of claim 1 in which the communication comprises packets.

3. The method of claim 1 in which the infrastructure includes a radio node controller.

4. The method of claim 1 in which the access terminal is in an idle state.

5. The method of claim 1 in which the communication sent over the control channel comprise a paging message.

6. The method of claim 1 in which the communication sent over the control channel comprise a UATI_Assignment message.

7. The method of claim 1 in which the communication sent over the control channel comprise a TrafficChannelAssignment message.

8. The method of claim 1 further comprising

notifying, by the access terminal, the radio node controller of sectors that are visible to the access terminal

9. The method of claim 1 further comprising

notifying, by the access terminal, the radio node controller of information about pilot strengths of sectors that are visible to the access terminal.

10. The method of claims 8 or 9 in which the notification is sent as a route update message.

11. The method of claim 9 further comprising
determining, based on the pilot strengths, to which sectors to send a communication over the control channel to the access terminal.

12. The method of claim 11 further comprising
enabling the radio node controller to send a communication to the access terminal over a control channel via sectors chosen based on their pilot signal strengths as reported by the access terminal, where at least one chosen sector is located in a different subnet than the radio node controller.

13. A method comprising,
in a radio access network including a first and a second subnet, in which the first subnet includes a first radio node controller,
enabling the first radio node controller to maintain an open traffic channel with an access terminal when the access terminal moves from a coverage area of the first subnet to a coverage area of the second subnet and when the access terminal uses a carrier in the first subnet that cannot be used in the second subnet.

14. The method of claim 13 in which each of the carriers comprises an operating frequency.

15. The method of claim 13 in which radio nodes in the first subnet are configured in accordance with one 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

16. The method of claim 15 in which radio nodes in the first subnet are configured in accordance with the 1xEV-DO Rev-A standard and radio nodes in the second subnet are configured in accordance with the 1xEV-DO Rev-0 standard.

17. A method comprising
in a radio access network including a first and a second subnet, in which the first subnet includes both a first radio node controller and radio nodes that are configured in accordance with one 1xEV-DO standard and the second subnet includes radio nodes configured in accordance with another 1xEV-DO standard,

enabling the first radio node controller to maintain an open traffic channel with an access terminal when the access terminal moves from the coverage area of the first subnet to the coverage area of the second subnet.

18. The method of claim 17 in which the radio nodes of the first subnet are configured in accordance with the 1xEV-DO Rev-A standard and the radio nodes of the second subnet are configured in accordance with the 1xEV-DO Rev-0 standard.

19. An apparatus comprising

a processor,

memory, including software to provide instructions to the processor to send packets to an access terminal over a control channel through the infrastructure of a subnet that is not the one to which the apparatus belongs.

20. The apparatus of claim 19 in which the software provides further instructions to the processor to receive notification from the access terminal of sectors that are visible to the access terminal.

21. The apparatus of claim 19 in which the software provides further instructions to the processor to receive notification from the access terminal of information about pilot strengths of sectors that are visible to the access terminal.

22. The apparatus of claim 21 in which the software provides further instructions to the processor to determine, based on the pilot strengths, to which sectors to send a communication over the control channel to the access terminal.

23. The apparatus of claim 22 in which the software provides further instructions to the processor to enable the apparatus to send a communication to the access terminal over a control channel via sectors chosen based on their pilot signal strengths as reported by the access terminal, where at least one chosen sector is located in a different subnet than the apparatus.

24. An apparatus comprising means for sending a communication to an access terminal over a control channel through an infrastructure of a subnet that is not the one to which the apparatus belongs.

25. The apparatus of claim 24 further comprising means for receiving notification from the access terminal of sectors that are visible to the access terminal.

26. The apparatus of claim 24 further comprising means for receiving notification from the access terminal of information about pilot strengths of sectors that are visible to the access terminal.

27. The apparatus of claim 26 further comprising means for determining, based on the pilot strengths, to which sectors to send a communication over the control channel to the access terminal.

28. The apparatus of claim 27 further comprising means for sending a communication to the access terminal over a control channel via sectors chosen based on their pilot signal strengths as reported by the access terminal, where at least one chosen sector is located in a different subnet than the apparatus.

29. A system comprising,

a packet data serving node connected to a network;

at least two subnets, each subnet including,

at least one radio node controller connected to the packet data serving node and,

at least one radio node connected to a radio node controller in the same subnet,

in which the radio node controllers are enabled to send a communication to an access terminal over a control channel through the infrastructure of another subnet.

30. The system of claim 29 in which the radio node controllers receive notification from the access terminal of sectors that are visible to the access terminal.

31. The system of claim 29 in which the radio node controllers receive notification from the access terminal of information about pilot strengths of sectors that are visible to the access terminal.

32. The system of claim 31 in which the radio node controllers determine, based on the pilot strength, to which sectors to send a communication over the control channel to the access terminal.

33. The system of claim 32 in which the radio node controllers send a communication to the access terminal over a control channel via sectors chosen based on their pilot signal strengths as reported by the access terminal, where at least one chosen sector is located in a different subnet than the radio node controller.

34. An apparatus comprising,

a processor,

memory, including software to provide instructions to the processor to maintain an open traffic channel with an access terminal when the access terminal moves from a coverage area of a first subnet where the apparatus is located to a coverage area of a second subnet and when the access terminal uses a carrier in the first subnet that cannot be used in the second subnet.

35. The apparatus of claim 34 connected to a network in which each of the carriers comprises an operating frequency.

36. The apparatus of claim 34 connected to a network in which radio nodes in the first subnet are configured in accordance with a 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

37. An apparatus comprising means for maintaining an open traffic channel with an access terminal when the access terminal moves from a coverage area of a first subnet where the apparatus is located to a coverage area of a second subnet and the access terminal uses a carrier in the first subnet that cannot be used in the second subnet.

38. The apparatus of claim 37 connected to a network in which each of the carriers comprises an operating frequency.

39. The apparatus of claim 37 connected to a network in which radio nodes in the first subnet are configured in accordance with a 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

40. A system comprising,

a packet data serving node connected to a network;

at least two subnets, each subnet including,

at least one radio node controller connected to the packet data serving node and,

at least one radio node connected to a radio node controller in the same subnet,

in which a first radio node controller located in a first subnet maintains an open traffic channel with an access terminal when the access terminal moves from a coverage area of a first subnet to a coverage area of a second subnet and when the access terminal uses a carrier in the first subnet that cannot be used in the second subnet.

41. The system of claim 40 in which each of the carriers comprises an operating frequency.

42. The system of claim 40 in which radio nodes in the first subnet are configured in accordance with a 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

43. An apparatus comprising

a processor,

memory, including software to provide instructions to the processor to maintain an open traffic channel with an access terminal when the access terminal moves from a coverage area of a first subnet where the apparatus is located to a coverage

area of a second subnet and radio nodes in the first subnet are configured in accordance with a 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

44. An apparatus comprising means for maintaining an open traffic channel with an access terminal when the access terminal moves from a coverage area of a first subnet where the apparatus is located to a coverage area of a second subnet and radio nodes in the first subnet are configured in accordance with a 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

45. The apparatus of claims 43 or 44 in which radio nodes of the first subnet are configured in accordance with the 1xEV-DO Rev-A standard and radio nodes of the second subnet are configured in accordance with the 1xEV-DO Rev. 0 standard.

46. A system comprising,

a packet data serving node connected to a network;

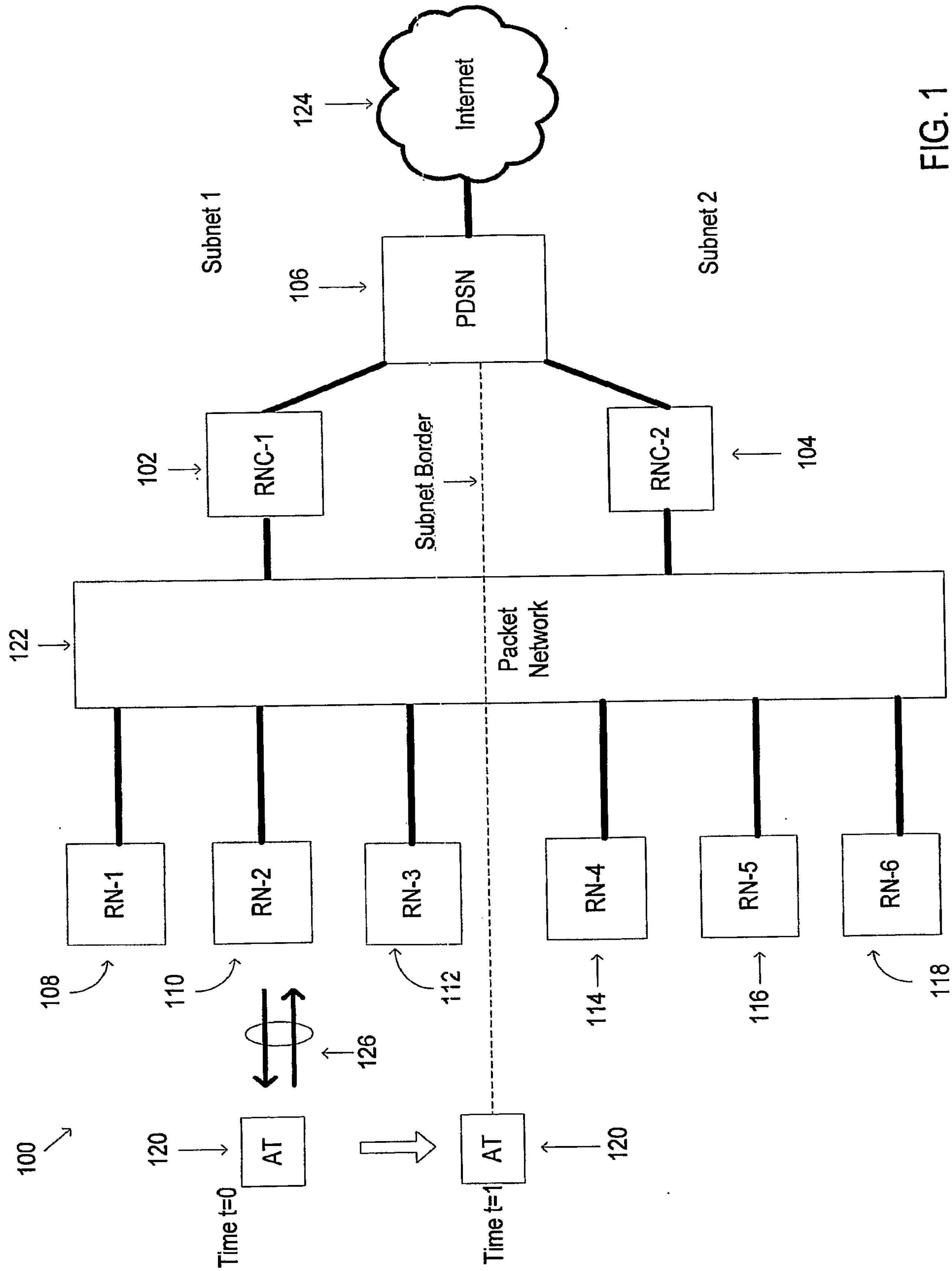
at least two subnets, each subnet including,

at least one radio node controller connected to the packet data serving node and,

at least one radio node connected to a radio node controller in the same subnet,

in which a first radio node controller located in a first subnet maintains an open traffic channel with an access terminal when the access terminal moves from a coverage area of a first subnet to a coverage area of a second subnet and radio nodes in the first subnet are configured in accordance with a 1xEV-DO standard and radio nodes in the second subnet are configured in accordance with another 1xEV-DO standard.

47. The system of claim 46 in which radio nodes of the first subnet are configured in accordance with the 1xEV-DO Rev-A standard and radio nodes of the second subnet are configured in accordance with the 1xEV-DO Rev. 0 standard.



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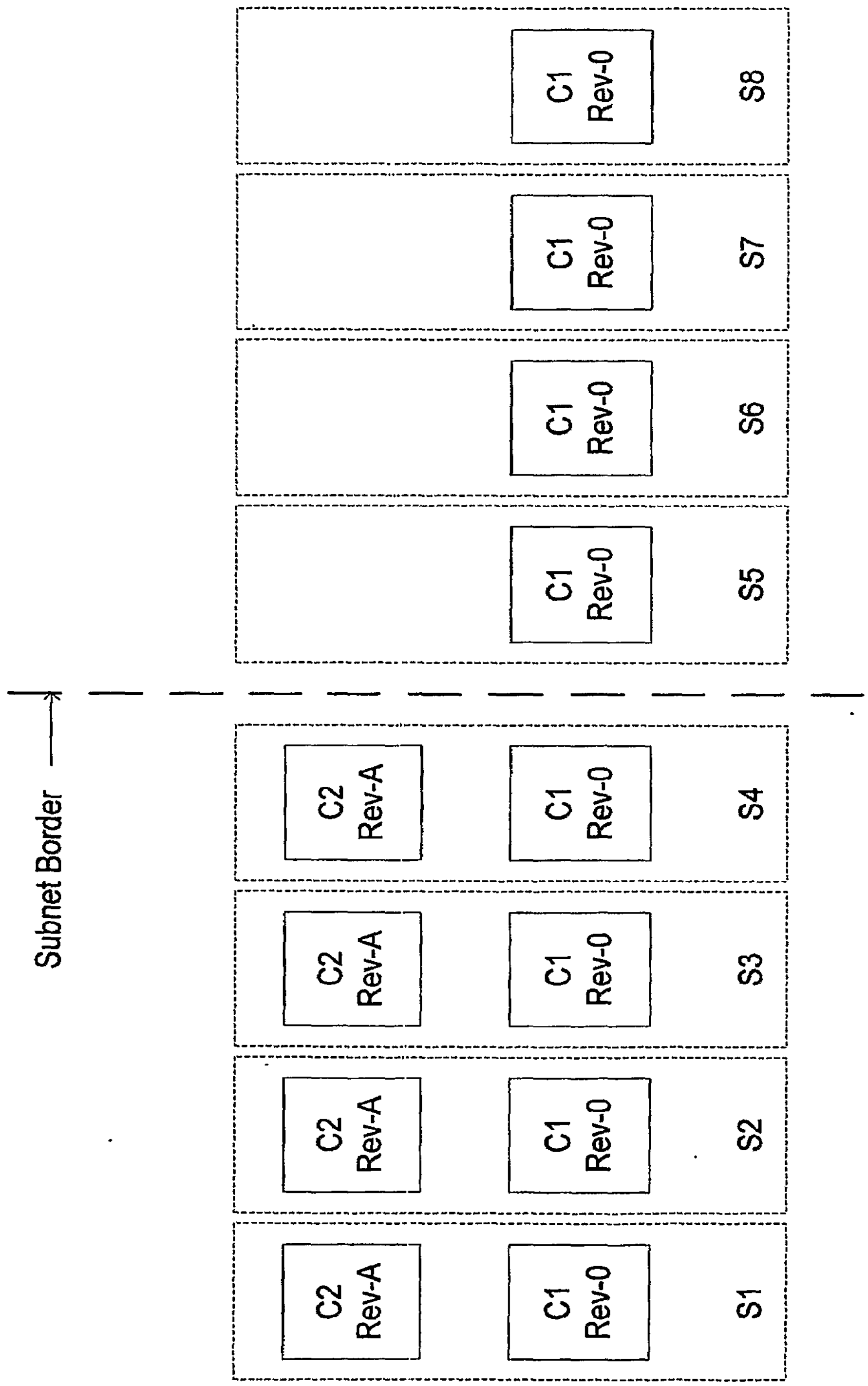
AT
126
Time t=1
AT
120
108
RN-1
110
RN-2
112
RN-3
114
RN-4
116
RN-5
118
RN-6
122
Packet Network
102
RNC-1
Subnet Border
RNC-2
104
Subnet 1
106
PDSN
Subnet 2
124
Internet

FIG. 1


Subnet Border
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C1 Rev-0
S1
C2 Rev-A
C1 Rev-0
S2
C2 Rev-A
C1 Rev-0
S3
C2 Rev-A
C1 Rev-0
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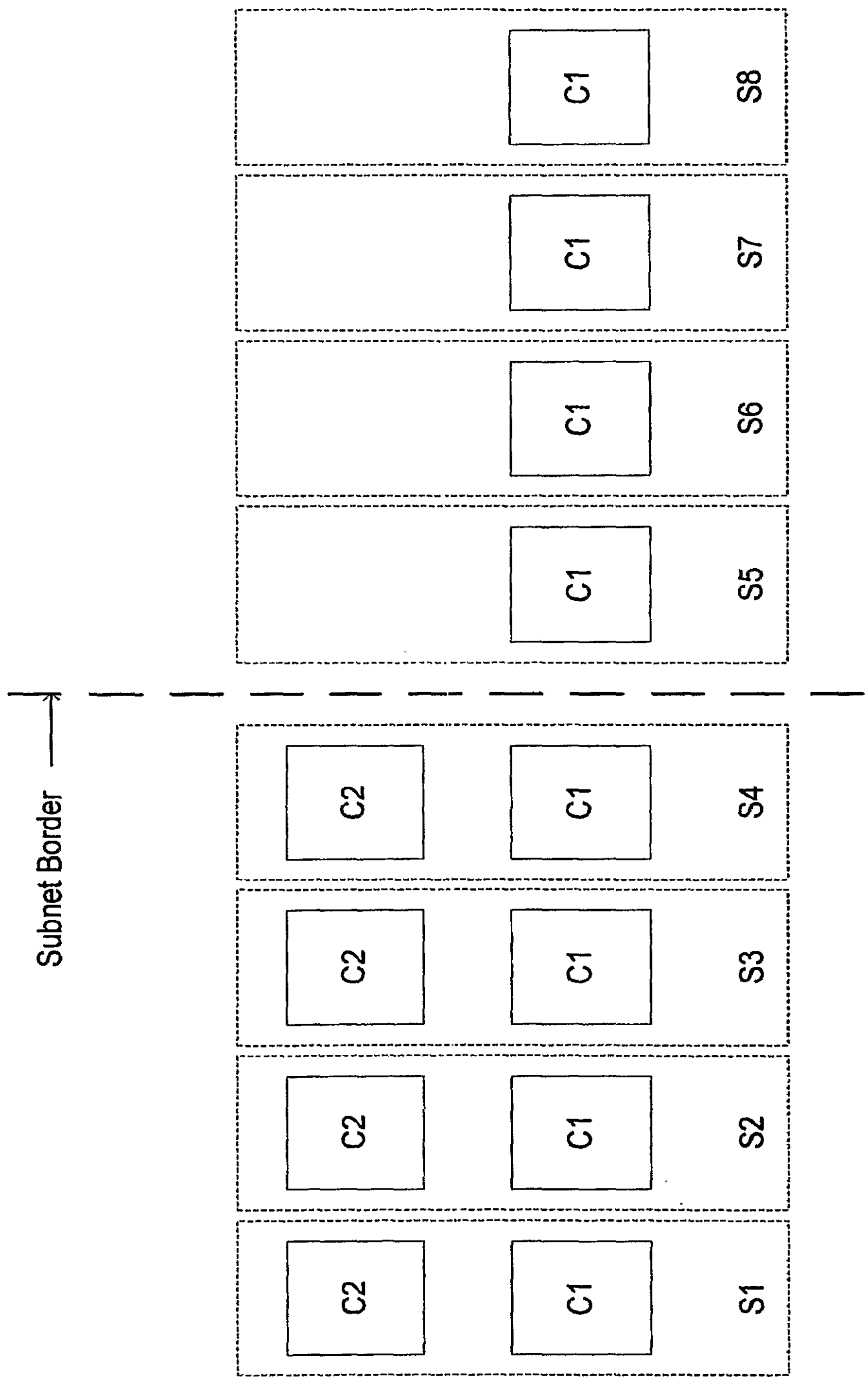
C1 Rev-0
S8

FIG. 2


Subnet Border
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C1
S1
C2
C1
S2
C2
C1
S3
C2
C1
S4
C1
S5
C1
S6
C1
S7
C1
S8

FIG. 3